Alfalfa Cultivar Variation for Minerals Concentration

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Introduction

Milk fever (parturient paresis) is a complex metabolic disorder that occurs at the beginning of lactation in many high-producing dairy cattle. The disease is characterized by a rapid decline in plasma Ca because of the demand for Ca to form colostrum in the milk. Severe hypocalcemia is thought to account for most of the clinical symptoms. If left untreated, most animals die. It is a greater problem in older cows than in heifers. Of the various methods used to control the disease, the most promising is dietary management of dry cows before parturition. Until recently, most attention has centered on manipulating dietary Ca. Recent work has focused on the cation-anion difference (CAD) in the diet as the factor determining the susceptibility of cows to milk fever. The CAD is thought to influence milk fever by affecting blood pH. A reduction in blood pH can be achieved by adding anions or by reducing the concentration of cations in the diet.

Horst et al. recently proposed that CAD be calculated as follows:

CAD (meq kg^{-1}) = (0.38 meq Ca^{++} kg^{-1} + 0.25 meq Mg^{++} kg^{-1} + meq Na^{+} kg^{-1} + meq K^{+} kg^{-1}) - (meq Cl^{-} kg^{-1} + 0.6 meq $SO4^{--}$ kg^{-1} + 0.5 meq $PO4^{---}$ kg^{-1})

This equation assumes that Na, K, and Cl are absorbed with 100% efficiency and that the remaining cations and anions are absorbed at lower efficiencies as shown by their coefficients. Addition of anions to the diet to reduce dietary CAD is a limited option because of reduced palatability associated with anionic salt sources commonly used. A more practical solution may be to reduce cations in the diet. Because of the high efficiency of absorption, recent work has focused on reducing K and Na. This study was conducted to determine if variation exists among alfalfa cultivars for cation mineral concentration and to determine the relationship between concentrations in leaves and stems.

Materials and Methods

Twenty alfalfa cultivars, representing five of the nine original germplasm introductions to the USA, were evaluated for mineral concentrations. Samples for this study were collected in 1993 and 1994. The alfalfa was harvested three times each year, but samples from only the first two harvests were studied. Maturity effects were controlled by selecting stems with only one raceme that had blooming florets. Leaves were separated from stems. Minerals concentration was determined by an atomic absorption spectrophotometer.

Results and Discussion

Significant cultivar variation for all minerals occurred in leaves, stems, and total forage (Tables 1 and 2) with the greatest variation for Na concentration. Results are shown here for only K and Na (Tables 1 and 2). There were some compensating effects so that cultivars low in one mineral were sometimes high in another. When milliequivalents of the cations were totaled according to the equation by Horst et al., the range was 724 meq kg^{-1} for 'Ramsey' to 794 meq kg^{-1} for 'ICI 645.' Often variation from environmental factors was larger than that for cultivars. For example, K concentrations were markedly higher in 1993 (20.2 g kg^{-1}) than in 1994 (17.6 g kg^{-1}) and higher in Harvest 2 (21.2 g kg^{-1}) than in Harvest 1 (16.6 g kg^{-1}). Ca concentrations were higher in Harvest 1 (12.7 g kg^{-1}) than in Harvest 2 (10.0 g kg^{-1}).

Conclusions

While variation exists among these diverse cultivars for minerals concentration, the range may not be great enough to have a meaningful effect on milk fever of cattle. We have yet to determine the anions of these samples. Other factors such as soil mineral concentration, crop maturity, and environmental conditions during crop growth may be more important in lowering cation concentration in alfalfa.

Table 1. Potassium concentration in leaves and stems of alfalfa cultivars. Data are averaged over two years and two harvests.

Cultivar	Stems	Leaves	Total forage
	- - - - - - - g kg^{-1} - - - - - - - -		
ABI 9144	18.2	20.9	19.7
Archer	17.3	20.5	18.9
Caliverde	16.5	20.9	18.7
Cherokee	16.7	18.3	17.5
Deseret	16.7	21.2	19.1
Gladiator	17.5	19.1	18.4
ICI 645	19.0	21.7	20.4
Iroquois	17.7	20.1	19.0
Norseman	17.5	18.9	18.3
Pioneer 5246	17.4	20.5	19.0
Pioneer 5364	17.8	20.0	19.0
Pioneer 5683	16.3	18.4	17.4
Quantum	18.9	20.8	19.9
Ramsey	18.2	19.3	18.8
Sarnac	17.8	21.2	19.5
Sarnac AR	18.0	21.0	19.5
Valor	17.8	19.0	18.4
WL 222	18.0	20.1	19.1
WL 322 HQ	17.6	20.7	19.2
Washoe	17.1	19.9	18.6
LSD(0.05)	0.91		1.11
Mean	17.6	20.0	18.9
Minimum value	16.3	18.3	17.4
Maximum value	19.0	21.7	20.4

Table 2. Sodium concentration in leaves and stems of alfalfa cultivars. Data are averaged over two years and two harvests.

Cultivar	Leaves	Stems	Total forage
	- - - - - - - - - g kg^{-1} - - - - - - - -		
ABI 9144	0.397	0.375	0.385
Archer	0.363	0.547	0.459
Caliverde	0.382	0.607	0.497
Cherokee	0.733	0.843	0.790
Deseret	0.169	0.256	0.238
Gladiator	0.360	0.456	0.413
ICI 645	0.388	0.398	0.393
Iroquois	0.230	0.328	0.283
Norseman	0.134	0.362	0.254
Pioneer 5246	0.348	0.396	0.373
Pioneer 5364	0.351	0.493	0.430
Pioneer 5683	0.316	0.612	0.461
Quantum	0.254	0.323	0.290
Ramsey	0.294	0.331	0.315
Sarnac	0.334	0.432	0.385
Sarnac AR	0.461	0.501	0.482
Valor	0.236	0.418	0.331
WL 222	0.224	0.422	0.329
WL 322 HQ	0.258	0.451	0.356
Washoe	0.220	0.460	0.348
LSD(0.05)	0.063		0.048
Mean	0.323	0.451	0.391
Minimum value	0.134	0.256	0.238
Maximum value	0.733	0.843	0.790